ENSURING NAVY

TRANSFORMATION

THROUGH AFFORDABLE METALWORKING TECHNOLOGIES

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NCEMT

NATIONAL CENTER FOR EXCELLENCE IN METALWORKING TECHNOLOGY

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President George W. Bush has emphasized "the importance of science and technology as forces for change in transforming U.S. Defense." The U.S. Navy Manufacturing Technology (MANTECH) Program is taking a leadership role in the transformation of the Navy fleet through the expeditious development and deployment of advanced manufacturing solutions.

The National Center for Excellence in Metalworking Technology (NCEMT), one of nine MANTECH-sponsored Centers of Excellence, is providing high-level, high-demand expertise to the Navy and to the defense industrial base. New, world-class metalworking solutions are essential to the development of vessels that are smaller, stronger and faster to ensure that U.S. Naval and military forces remain preeminent in the future.

The people of the NCEMT are committed to providing unprecedented support for our country's warfighters. I am, as always, confident in their abilities and proud of them for their efforts.

Sincerely,

Steven M. Linder
Director
Manufacturing Technology
(MANTECH) Program
Office of Naval Research

The continuing goal of the National Center for Excellence in Metalworking Technology (NCEMT) is to work with the U.S. Navy and the defense industrial base to rapidly advance affordable new combat systems. We are partnering our efforts, sharing our insights, energies and resources and pushing the boundaries of today's technologies as far as we can, as fast as we can.

In support of directives from our Commander in Chief and from the Chief of Naval Operations, the NCEMT is actively involved in the military's transformation. This year, more government and industry partners than ever before have sought our expertise; we are dedicated to responding to their needs and serving them well.

Since 1988, the NCEMT has developed and disseminated advanced metalworking technologies. The NCEMT applies these technologies to solve productivity problems and to design reliable, cost-effective solutions for the U.S. Navy and Department of Defense. Each year, the NCEMT builds on past successes to meet the diverse needs of its partners.

This publication highlights several important projects under way at the NCEMT. I would like to take a moment to credit the people behind these projects. The engineers, scientists and staff of the NCEMT are a dedicated group who challenge themselves to work harder and push beyond what is known . . . into the unknown and often uncharted areas of applying science and technology.

I consider it a privilege to work with individuals who constantly ask more of themselves and their industry. These people won't settle for average. They won't stop until they find workable, reliable solutions to better serve the crews of the U.S. Navy.

We at the NCEMT invite you to meet with us to discuss how we can provide metalworking solutions to suit your specific needs. Please don't hesitate to contact me at 1-800-282-4392.

Sincerely,

Richard J. Henry
Program Director
National Center for Excellence in Metalworking Technology

STATE OF THE NCEMT

In this time of historic change, we at the NCEMT are responding to the challenge to rapidly transform U.S. Navy and defense capabilities. We are adopting new paradigms and reaching beyond old expectations to assist civil and military partners who are in need of our services now more than ever before.

At the NCEMT, the commitment to transformation is deep, fundamental and unwavering.

Dynamic Transformation

As the military's transition to a new dynamic drives the MANTECH Program to transform itself, there is a renewed focus on transitioning innovative new technologies to the industrial base and supporting key Naval weapons systems of the future. The NCEMT is poised to leverage its knowledge and resources to solve high-stakes defense manufacturing challenges. Quickly. Affordably. Reliably.

As we work together to forge a way ahead for U.S. defense, benefits of our cooperative transformation efforts are already emerging.

People Meet Goals

The NCEMT has been invited to participate in a long list of high-level projects—a testimony to our long history of getting the job done right. Our experts consistently deliver quality solutions.

NCEMT engineers and scientists are involved in solving problems related to key Navy systems, such as the Joint Strike Fighter, the Advanced Amphibious Assault Vehicle (AAAV), the DD(X) 21st Century Destroyer and the Standard Missile, as well as advanced combat vehicles for the Army . . . and are achieving incredible results.

The NCEMT has earned a reputation for excellence and is diligently working to ensure that the world's most sophisticated defense program will continue to be the world's most capable. ■

One Bridge Ten Minutes

The U.S. Army Tank-automotive and Armaments Command (TACOM) needed a 13–24 meter bridge that could be deployed or recovered in 10 minutes by just two soldiers, support specific vehicles up to Military Load Classification 40 for caution crossings and meet a number of other stringent requirements.

NCEMT engineers created two designs for the new Advanced Metallic Army Bridge—the lightest, most rapidly deployable bridges ever. Bridges that take full advantage of advanced metallics, leading-edge manufacturing techniques and American ingenuity. The results have met with such success that the NCEMT team has been asked to participate in a follow-on project to design a prototype.

This is one of many examples you'll read about in the 2002 annual report. One of many innovative, cost-effective solutions that the NCEMT is delivering to meet the transformational needs of the U.S. military.

SHIPS & SUBMARINES

Sea superiority. Next-generation technology will ensure that the U.S. fleet continues as the unchallenged world leader, providing the nation with unprecedented defense capabilities.

The cornerstone of the U.S. Navy's 21st Century transformation program and the centerpiece of a new family of surface combatants is the DD(X). The most capable, most survivable ship ever produced, the DD(X) land-attack destroyer will be smaller, faster, more lethal, and will require fewer sailors.

The sleek new warship fits President George W. Bush's "commitment to building a future force that is defined less by size and more by mobility and swiftness, one that is easier to deploy and sustain, one that relies more heavily on stealth, precision weaponry and information technologies."

The DD(X) is to the sea what the Joint Strike Fighter is to the sky. Both will bring transformational capability to U.S. defense, and the NCEMT is proud to be supporting these landmark projects.

Superior Plate Forming For DD(X) Ship Hull

The Navy Joining Center (NJC) and the Institute for Manufacturing and Sustainment Technologies (iMAST), MANTECH Centers of Excellence, have shown that thermal sources may be used to deform large plates without hard tooling. The NCEMT was tasked to team with NJC and iMAST to further this research and to recommend the most beneficial forming system for the DD(X) future combatant ship hull plates.

The outer hull of naval combatants is constructed of moderately thick steel plating. Regions of this plating require complex, three-dimensional curvature for hydrodynamic and signature considerations. Because hull plating is only a small part of the total construction cost for a ship, plate-forming processes have not been optimized and historically have required large amounts of skilled labor.

Additional signature requirements levied on the DD(X) increase technical challenges for plate forming. The thermal plate forming process must be capable of accurately generating a complex three-dimensional curve along large portions of both thick and thin plating. Overall, tolerances on plate fairness for both flat and curved regions are more stringent for the new DD(X) than for other ships of the fleet.

To help meet these construction needs, the NCEMT evaluated automated thermal forming systems available in the U.S. and abroad. With input from its teammates, shipbuilders and other key stakeholders, the NCEMT has issued recommendations designed to meet the transformational needs of the U.S. Navy's newest warship.

The NCEMT has concluded that, if the recommended automated thermal plate forming system was used on all hull plates that require forming, a 20 percent reduction in rework and a 50 percent reduction in direct labor could be achieved.

Flash-Rust Testing To Assist Shipyards

Building a better hull is one thing; keeping it in an excellent state of repair is another.

Flash-rust is a thin layer of tightly adherent oxide film that requires substantial effort to prevent, minimize and repair. Currently, there is no objective method for measuring flash-rust. The issue is important because reducing the occurrence and severity of flash-rust on ships and submarines with a standardized method will save time and reduce blasting-and-painting costs.

Tests underway at the NCEMT are expected to produce a recommendation for a quantitative, Navy-approved measurement technique and

standard. This is expected to result in an estimated 80 percent reduction in rework associated with flash-rust to restore surfaces to specified conditions, which translates into significant annual savings for every shipyard that builds Navy vessels. Being able to measure flash-rust and to understand how it affects coating performance will also help shipyards decrease the likelihood of coating failures.

Concurrent Effort Improves Sub Fasteners

A concurrent effort by the NCEMT, Timken Latrobe Steel, SPS Technologies, Electric Boat Corporation and the Navy Surface Warfare Center-Carderock Division (NSWCCD) has led to the development of new high-strength marine-grade fasteners. The first application for the new fasteners will be aboard the Virginia-class submarines.

To meet Navy requirements for added strength, corrosion resistance and toughness, the NCEMT worked with the material supplier, Timken Latrobe Steel and NSWCCD to provide a material that fulfilled these stringent NAVSEA requirements. The NCEMT conducted material property evaluations and characterizations to verify that the properties of MP 98T, formerly called MP 159 modified, would be sufficient for use aboard U.S. Navy submarines. Manufacturability issues and implementation concerns were also addressed with SPS Technologies and Electric Boat Corporation during the development of the new fasteners.

Continuing evaluations include crevice corrosion testing at NRL-Key West and galvanic compatibility testing at CTC's facility in Largo, Florida. These evaluations are expected to show that the new high-strength marine-grade fasteners will meet U.S. Navy requirements and provide a more dependable and stronger fastener for the Virginia-class submarines. ■

Greyhounds Of The Sea

The U.S. Navy is commemorating the centennial anniversary of a vessel whose transformation is historic. U.S. destroyers, greyhounds of the sea, were commissioned in 1902.

Destroyers evolved from the need to counter a warship which made its devastating debut in the Chilean Civil War of 1891. The swift, small torpedo boat could surprise large ships by moving in close, deploying torpedoes and dashing away.

The U.S. Navy answered with the destroyer. From that first 1902 version to the famous ships of World War II to the Spruance-class to the Arleigh Burke-class, the U.S. Navy's destroyers have been evolving. The evolution continues into the 21st Century with the much-anticipated arrival of the DD(X), the Zumwalt-class.

AIRCRAFT

From the first propeller-driven fighters to today's sophisticated, pilotless planes, the U.S. has built the finest military aircraft the world has ever seen. The dramatic transformation of U.S. aircraft is continuing, and the NCEMT is contributing to the development of advanced technology solutions for high-profile defense projects such as the F-35 Joint Strike Fighter (JSF).

The next-generation F-35 is a stealthy (radar-evading), supersonic multi-role fighter designed to meet the U.S. Government's requirements for a new generation of transformational weapons. Affordability is the cornerstone of the F-35 JSF according to Lockheed Martin Aeronautics Company. Lockheed is developing the F-35 in conjunction with principal partners Northrop Grumman and BAE Systems. The NCEMT is an active partner in several projects related to the F-35, including the three that follow.

Manufacturing Titanium Matrix Composites For Rotating Parts

The NCEMT is working to develop affordable new manufacturing applications for titanium metal matrix composites (TMCs) for rotating components (specifically discs and spacers) used in the JSF F136 engine. TMCs will probably always be more expensive than most other materials; however, they are highly durable, thus providing the potential for significantly improved life-cycle costs.

To date, TMCs have not been used for rotating components in jet engines because of high manufacturing costs and the lack of critical design data. This project, a collaborative effort involving the NCEMT, Rolls-Royce plc and FMW Composite Systems, is already making great strides to change the status quo.

TMCs are not just durable, they are light. Preliminary findings suggest that there are high payoff applications if TMC rotating components can be used extensively in the F-35 compression system. The specific stiffness and strength requirements at elevated temperatures are such that steel as well as titanium alloy disks and spacers could be replaced with TMC parts, reducing weight and life-cycle costs for the F-35.

Forging Supplier Initiative Achieving Cost Savings

The F-35 fits the concept of transformation—a multi-service aircraft that meets broad and differing mission requirements. In fact, the JSF will be manufactured in three versions: a conventional takeoff-and-landing variant for the U.S. Air Force, an aircraft-carrier version for the U.S. Navy and a short-takeoff/vertical landing version for the U.S. Marine Corps.

The Air Force-sponsored Forging Supplier Initiative aims to lower by 35 percent the acquisition costs of aerospace forgings such as airfoils, cases, integrally bladed rotors, rings and shafts. As a result of new technologies developed by the NCEMT and its partners, cost savings of about 15–20 percent for large engine disks and about 15 percent for rolled-ring cases are anticipated.

To impact one of the most significant areas identified for cost reduction—materials utilization (which affects the buy-to-fly ratios)—this Navy MANTECH project focuses on providing technical support and development to the Air Force program in the following four areas:

1. Ring-rolling simulation tools
2. Incremental forging design through MSC.SuperForge simulation
3. Advanced friction and heat transfer models for forging simulations
4. Workability of Ti-6-2-4-2 in cold spin/flow forming of thick-walled preforms

New ring-rolling design tools developed for forging suppliers represent a significant achievement. The Air Force and Navy are expected to save $1.44 million in five years on ring-rolled engine cases by adopting these design tools and associated manufacturing practices.

With support from the Air Force and Pratt & Whitney Aircraft, the NCEMT has transitioned tools and technologies to industry such as Firth-Rixson Viking. There, engineers have received training on a quick-execution software tool for ring-rolling preform and die design called preForma-ring™. Implementation of this and other new technologies demonstrates an integrated strategy aimed at making the U.S. forging supplier base more competitive.

Reduced Buy-to-Fly For Engine Parts

A new NCEMT project is leveraging work done on the Forging Supplier Initiative to help reduce the cost of manufacturing integral arms and flanges of gas turbine engine disks and integrally bladed rotors. Pratt & Whitney, manufacturer of F135 engine for the F35 JSF, has teamed with the NCEMT for this project.

Engineers are adapting rotary-forming processes such as flowforming, shear forming and/or roll forming to manufacture the parts at reduced costs. Currently, integral arms and flanges of turbine disks are made on closed-die forging processes (only axial die motion) in shapes that encompass the integral arm features. Accounting for these features in the forged preform requires additional material, which leads to a high buy-to-fly ratio. In making the finished part, this additional material must be removed by machining, thus raising the cost.

Typically, buy-to-fly ratios for integral arm compressor disks range from 4:1–8:1, and in some cases they can be as high as 15:1. By employing new forming practices such as flowforming, coupled with both forge-over-finish preform design concepts and contour following ultrasonic testing, the input forging weight can be greatly reduced.

Through continued technical innovation and successful industrial implementation, the NCEMT extends its mission of support to the nation's most important new aircraft—one fighter that meets the needs of the Air Force, Navy and Marines. ■

Demonstration Facilities

To demonstrate, train and transfer newly developed metalworking technology methods to the U.S. Navy and the nation's industrial base, the NCEMT maintains state-of-the-art, production-scale demonstration facilities. These facilities include a 600-ton customized die-casting machine, a superplastic fabrication press, a six-station induction heating system for semi-solid metalworking, an 850-ton vertical hydraulic press for forging and extrusion, a 100-ton powder compaction press, a 110-ton powder injection molding machine and sintering furnaces. The NCEMT is well equipped to meet clients' needs. Read more about NCEMT capabilities at www.ncemt.ctc.com.

MISSILES/ORDNANCE

Pioneering accomplishments in advanced metalworking technologies are paving the way for the transformation to a lighter, faster, highly mobile fighting force. NCEMT engineers, in conjunction with civil and military partners, are finding affordable new ways to use materials such as aluminum alloy 2519, rhenium and low-cost titanium . . . and are achieving incredible success.

As a result, the Marines will now have a fast-moving amphibious craft that can "attack from over the horizon." The weight of the next-generation Howitzer has been cut by more than half—yet its precision and lethality have been greatly improved. Here, in detail, are a few of the reasons why.

NCEMT Optimizes Alloy 2519 For AAAV

The Advanced Amphibious Assault Vehicle (AAAV) is the United States Marine Corps newest weapons system platform. Designed to carry 18 personnel and a crew of three, it is an advanced-combat vehicle that moves three times faster and carries greater firepower than the current amphibian, providing the Marines greater flexibility and a superior tactical advantage.

The combined mission demands for the AAAV require high degrees of survivability, mobility, lethality and reliability while minimizing weight. To meet the AAAV mission requirements, the prime contractor, General Dynamics, selected alloy 2519 as the primary structural material for the hull, mainly because of its high strength and superior ballistic penetration resistance against certain threats.

Although aluminum 2519 had been used in plate form, there was little mechanical data or application experience for forgings or extrusions. Furthermore, it was essential that adequate corrosion protection systems be found for the alloy.

The NCEMT successfully developed the manufacturing technology for 2519 extrusions (Stanchion and T-Section geometries) with mechanical properties superior to the 6061 extrusions used in the AAAV prototypes. The 2519 extrusions demonstrated a 28 percent increase in yield strength and a 47 percent increase in tensile strength with comparable elongation to 6061. In addition, a successful paint/coating system for the AAAV has been identified.

Furthermore, as an alternative to gas metal arc welded 2519 butt joints, which exhibit low ductility and do not pass ballistic shock impact testing, the NCEMT developed friction stir welding (FSW) technology for 2519. This technology enabled FS butt and corner welds to pass the demanding ballistic shock impact test while increasing weld strength 47 percent and tripling weld ductility. A 2519 AAAV floor mine blast test article was fabricated using FSW and was sent to the U.S. Army's Aberdeen Test Center for simulated mine-blast testing. The FSW joints fully met all requirements set by the AAAV Program Office for the AAAV design. The success of this test demonstrated the viability of this technology for AAAV production and other combat vehicle platforms.

Titanium Cuts Weight Of XM777 Howitzer

Two new projects focus NCEMT efforts on implementing titanium in the manufacture of new artillery that will be used by both the U.S. Army and the U.S. Marine Corps. Again motivated by the need to transform defense capabilities, military planners seek to replace aging M198 155mm Howitzers with lighter, faster artillery requiring fewer crew members.

The XM777 lightweight 155mm Howitzer (also called LW 155) matches the firepower of current-generation 155mm towed systems at less than half the weight. The new Howitzer is equipped with a 39-caliber barrel and has a maximum firing range of 24.7 km with unassisted rounds and 30 km with rocket-assisted rounds. The XM777 is capable of delivering up to five rounds per minute under intense

firing conditions and can provide a sustained rate of fire of two rounds per minute. Although Howitzers typically require a crew of 10, the XM777 can be operated with a detachment of five.

The lighter weight of the XM777 results in superior maneuverability when compared to the M198 Howitzer and allows for transport by helicopter, transport aircraft and ship.

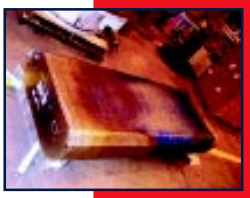
The current design of the XM777 calls out a structure fabricated from multiple parts. This labor-intensive approach requires more than 6000 labor hours of highly skilled titanium welders. In addition, welding of titanium creates technical issues due to the variability inherent in the process. The NCEMT is addressing all of these issues, working to identify efficient, lower-cost manufacturing processes. Castings, for example, can be attractive cost-reducing alternatives because they can reduce part count, utilize low-cost titanium raw materials and decrease variability of components.

Forging Improvements Further Enhance Howitzer

Other XM777 parts must be forged, and several of these parts are the focus of a separate NCEMT project. By applying advances made in titanium plasma arc melting (PAM), NCEMT engineers are developing better, more cost-effective ways to manufacture several components of the Howitzer currently produced from vacuum arc remelted (VAR) product.

Unlike VAR, PAM of titanium does not require multiple melt steps. VAR typically requires double or triple melting to ensure product quality, making this process expensive. The NCEMT is currently working with RMI Titanium Co. to optimize the PAM process to produce single-melt ingots of sufficiently high quality that they require little or no conditioning prior to forging, thereby increasing yield and reducing cost. PAM enables the use of lower-cost feedstock material that results in a higher oxygen impurity content which can reduce ductility, toughness or fatigue behavior at certain levels.

The NCEMT is optimizing the tradeoffs between cost, oxygen content and mechanical properties for forgings. This will reduce the production cost of Ti-6Al-4V components that meet or exceed XM777 design requirements, further improving the cost-effectiveness.



Titanium Armor Plate

"Because the principal market for titanium has been the aerospace industry, its current production processes are intended to produce exceptionally high quality material. However, armor plate and similar applications do not require the degree of processing required for manufacturing rotating components in the aerospace industry. . . .

"Casting single-melt titanium into rectangular molds provides the opportunity for a single-step direct rolling process into plate, increases the material yield, results in mechanical properties comparable to those from conventionally processed material and reduces cost. Until this work was conducted, attempts to cast titanium slabs using PAM had not been successful. In contrast, the modeling and PAM casting parameters developed in this work enabled slabs to be cast with acceptable surface quality."

– Advanced Materials & Processes Magazine, September 2002. Written by Edward J. Fasiska, Yuan Pang, Robert Dax, NCEMT, et. al.

MISSILES/ORDNANCE

Improving Reliability Of Thermal Batteries

One way to further improve readiness and performance without budget augmentation is to improve thermal battery reliability. The military uses these batteries to power sonobuoys, guided artillery, missiles, guidance systems and countermeasure devices.

The NCEMT has identified process improvements for manufacturing thermal batteries used in the AN/SSQ-62E and the Joint Direct Attack Munitions (JDAM) Guidance Kit and is in the process of testing these improvements in production at Eagle Picher.

The technology developed to improve the thermal battery manufacturing process will be implemented and demonstrated on an airborne ASW sensors and special missions (PMA-264) application. This technology may also be applied to air-to-air missiles and conventional weapons. In addition, the technology can benefit many other Department of Defense (DoD) weapons systems.

Groundbreaking Advances In Rhenium Processing

The NCEMT has identified groundbreaking new lower-cost manufacturing methods that decrease the surface roughness of rhenium parts by 60 percent. The success of the Rhenium Fabrication Process project has had a positive impact on the entire U.S. industrial base and will broaden the number of machine shops able to process rhenium.

The impetus for the project: The U.S. Navy wanted to reduce manufacturing costs and excessive lead times that currently affect the deployment of propulsion systems containing rhenium components, such as that of the STANDARD Missile 3.

Rhenium is the material of choice for many critical applications such as propulsion components because its tensile strength at 900°C (3452°F) is around 193 Mpa (28 ksi) and it is immune to thermal shock. Rhenium is compatible with most propellants, and in the environs of space it can successfully endure severe thermal cycles with ease. However, manufacture of rhenium components presents a formidable challenge because it is very difficult to form into complex shapes. Currently, machined rhenium components have quality problems and unacceptably long production times. Also they are very expensive as they are practically impossible to single-point machine. The number of machine shops with rhenium experience is few.

The NCEMT successfully addressed these issues by demonstrating the advantages of a multi-pass wire electric discharge machining (EDM) process on rhenium parts. In addition to decreasing surface roughness, this process reduced the recast layer to less than one micron and nearly eliminated all microcrack surface damage. Commercial vendors identified favorable settings for various EDM machines to help develop a method of process qualification and to expand the supplier base for rhenium processing. Using the NCEMT's multi-pass process, the commercial vendors were able to successfully repeat the NCEMT's results using a variety of machines, standard wires and dielectric fluids.

New Ag-Zn Batteries For STANDARD Missile 3

Another project aimed at improving the STANDARD Missile 3 involves the development and implementation of a new commercial-scale production process for fabricating batteries made of zinc and silver oxide plates. The U.S. Navy STANDARD Missile Program Office has asked the NCEMT and members of an integrated project team to determine the feasibility of scaling-up new technology that has been demonstrated to work in a laboratory.

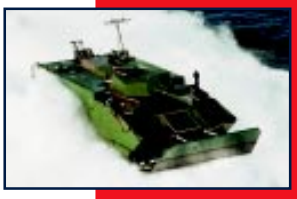
The new high-discharge technology, successfully demonstrated by EMF Systems of Boulder Creek, California, produces chemically pure electrodes and provides a uniform reaction interface that results in greater discharge efficiency. It simplifies battery construction and greatly reduces plate-formation labor costs.

If EMF-developed technology is adaptable, the next-generation silver-zinc missile battery is expected to have increased discharge efficiency, shortened rise time, a longer shelf life and improved reliability as compared to current silver-zinc batteries.

Flowformed Cartridges Reduce Expenses

Technical success has been achieved on a project that optimizes cartridge cases using new flowforming manufacturing processes developed by the NCEMT in conjunction with the Naval Surface Warfare Center-Indian Head (NSWC-IHD). This project supports the transition of Navy gun capabilities to higher impetus rounds with superior capabilities.

Navy five-inch guns use a steel cartridge case to contain the primer and the propellant for the round. These cases had been manufactured using the deep-drawing process, which is no longer cost effective. The NCEMT has supported the NSWC-IHD in the selection of specific steel alloys, development of a heat treatment process and design of the manufacturing process to enhance the performance of the case in firing both standard and Extended-Range Guided Munitions (ERGM)—all while reducing production costs. Final test firing of cases made from the low-alloy steel, 94B15, are being scheduled. ■



NCEMT Technology Success Story

The NCEMT conducted a manufacturing study to identify the lowest cost process to produce the flat, double-angle cross-section turret ring for the Advanced Amphibious Assault Vehicle (AAAV). Roll forging (also called ring rolling) was determined to be the most favorable method for fabricating the AAAV turret ring. However, Al-Cu-Mg alloy 2519, the vehicle's main structural alloy, had not previously been roll forged.

During manufacturing trials to determine the forgeability of 2519, the NCEMT and Rotek, Inc. of Aurora, Ohio, successfully manufactured several prototype 2519 turret rings—establishing a new product form for 2519. The properties of the new rings greatly exceeded the minimum 2519-T6 tensile requirements. In addition, the cost to roll forge these prototype AAAV turret rings was approximately 55 percent of the baseline cost to machine the turret rings from plate stock.

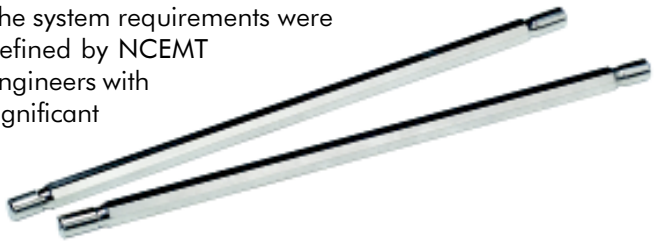
LEVERAGING CAPABILITIES

Collaboration—utilizing the brightest ideas from the finest sources—is essential to realizing the promise of transformation. To enhance the tools available to U.S. warfighters in an expeditious, cost-effective manner, the U.S. civil-military industrial base must avoid duplication of effort. If capabilities and/or technologies developed from one project can benefit another project, knowledge transfer must take place. Information sharing advances the military's strategic evolution and helps ensure readiness objectives.

As an important national resource for developing and disseminating world-class metalworking technology, the NCEMT has worked since its inception to expand the world knowledge base while it builds upon its own past successes. By leveraging proven technologies whenever possible, the NCEMT helps lower initial development costs and moves projects along quickly.

Combat Vehicle Research

To qualify friction stir welding (FSW) for use on the Advanced Amphibious Assault Vehicle (AAAV), the NCEMT developed welding tools and parameters for making high-strength, high-productivity welds in both flat butt and 90° corner configurations. Ultimately, as the project progressed and success was achieved (see section on AAAV), the NCEMT recognized the need to further leverage this particular expertise. The NCEMT work generated interest in the Tank-Automotive Research, Development, and Engineering Center (TARDEC) in FSW. Under TARDEC sponsorship, in 2002, the NCEMT installed a new FSW facility that is capable of welding full-size combat vehicles and other large structures. The system requirements were defined by NCEMT engineers with significant input from TARDEC, combat vehicle prime contractors, and the AAAV Program Office. Built by Mid Columbia Engineering Technologies of Seattle, Washington, the facility is the only one in the world specifically built to fabricate a full-size combat vehicle. The NCEMT plans to make this key asset available to U.S. Government laboratories and contractors for contract research and development and prototype construction.



One Bridge. Ten Minutes.

NCEMT engineers created two concepts for the Lightweight Advanced Metallic Bridge by applying their knowledge of advanced manufacturing methods, including full-length extrusions and FSW joints, and their experience with alloys such as 7055, 2094 and Ti-15-3. By leveraging current knowledge, the engineers developed designs that met stringent requirements such as: bridges capable of being deployed or recovered by two soldiers in 10 minutes and able to span 13–24 meters while supporting military-load vehicles. The success of this transformational project has led to a plan for further funding to refine the concepts.

Titanium Armor Plate

Titanium is frequently chosen for high-performance military components because of its low density, high strength and corrosion resistance. However, cost has prohibited titanium's application in most Army equipment. At the NCEMT, researchers have improved the plasma arc cold hearth melting (PAM) process to successfully cast titanium slabs with acceptable surface quality. The PAM method developed during this study, with help from the U.S. Army through TARDEC and ARDEC, was used to produce titanium alloy armor for combat vehicles at a cost significantly lower than possible with current commercial processes.

This armor plate has been implemented on the Integrated Hybrid Structure demonstration model that TARDEC developed, which opens the door to enhanced performance of military vehicles and other weapons systems at an affordable cost.

Redesigning Seahawk's Dynamic Components

After more than 24 years of steady service, the H-60 Seahawk helicopter is undergoing transformational studies to better enable it to meet new mission requirements. The PMA 299 Program Office has tasked the NCEMT to apply its design and analysis capabilities in addressing component lifting problems.

Since 1978, more than 100 dynamic components of H-60 Seahawk helicopters have been individually tracked and replaced based on flight-hour life and physical condition. This analysis has yielded specific corrosion and wear data for each of these dynamic components. The Naval Air System Command MH-60R Air Vehicle Team found that life limits across all H-60s are decreasing because of increasing weight and power as well as changing mission profiles. The life limits on 50 percent of the tracked components were reduced by an average of 60 percent.

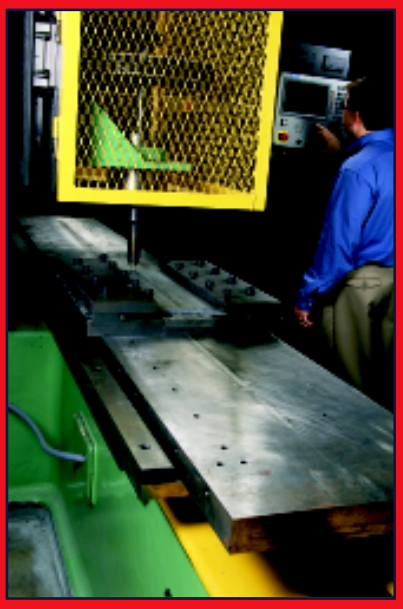
The NCEMT has just begun research to determine how to increase the life limits of dynamic components and to improve their resistance to corrosion and wear.

InfraRed System Studied

H-60 series helicopters are required to employ a Forward Looking InfraRed (FLIR) system. Both the MH-60S and MH-60R helicopters require a sensor with a laser-range finder/designator system that has minimum airframe interference. The legacy design requires that the FLIR be mounted in an inverted position from its intended design—a configuration that interferes with the look-down capability and that allows water penetration, causing corrosion.

The NCEMT is working to develop a new FLIR mount that will improve operational reliability. Once complete, the new MH-60S FLIR system will be retrofitted on the MH-60R.

These and other examples illustrate that leveraging proven technologies makes good business sense. The NCEMT works to ensure that capable new technologies can be adapted cost-effectively and successfully, extending the service life of existing systems . . . transforming the capabilities of next-generation craft . . . making the best military even better. ■



TECHNOLOGY TRANSFER

The transformation of the U.S. Navy must be as swift as the fastest ship in the fleet. And the fleet must become faster and more agile to respond to the new realities of 21st Century combat. Technology transfer is one means of ensuring that important new technology is tested and deployed quickly and successfully.

Historically, the NCEMT and its partners have planned for technology transfer at the start of each new project. Today, motivated by and dedicated to the mission of Naval transformation, scientists and engineers are even more diligent in the effort to disseminate useful findings to applicable civil-military audiences in the most expeditious manner.

Workshops, conferences and publications are among the wide-ranging tools that the NCEMT used in 2002 to share information with a nation-wide audience.

FSW Workshop Successful; Next Set For October 2003

In May 2002, the Navy MANTECH Program of the Office of Naval Research sponsored a successful first workshop focused on Friction Stir Welding (FSW) Technology for Defense Applications. The ITAR-restricted workshop, held in Columbus, Ohio, was organized jointly by the NCEMT and the Navy Joining Center (NJC) and was hosted by the Edison Welding Institute.

Representatives from the U.S. Army, Air Force and Navy addressed applications for FSW in their respective weapons systems. Fourteen technical presentations by respected experts covered current and/or planned applications of FSW to systems as diverse as the Marine Corps Advanced Amphibious Assault Vehicle, the C-17 and C-130 cargo planes and the space shuttle. Advances in applying FSW to armor-grade steel, stainless steel, superalloys and titanium, as well as aluminum alloys, were also described. The workshop concluded with a discussion on future FSW development.

The next workshop is scheduled for October 14–15, 2003, in Johnstown, Pennsylvania. It will be hosted by Concurrent Technologies Corporation (CTC) and will again be co-organized by the NJC and the NCEMT.

New NCEMT Web Site Enhances Technology Transfer

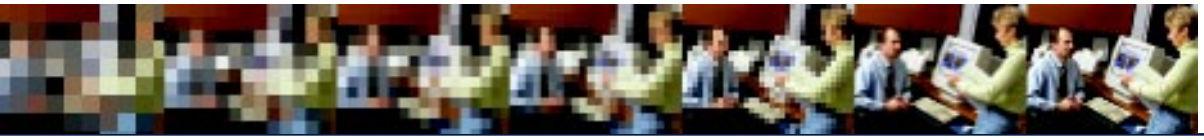
In August 2002, the NCEMT premiered a fully revised Web site designed to be more user-friendly and informative. Sections on core capabilities, technology areas and NCEMT projects help visitors to the site find what they need quickly. Concise, well-written explanations link the visitor to as much detail as desired. Topics range from metal casting to process modeling and simulation. A discussion of important past projects and all current projects serves two purposes: to share information and to help visitors who are searching for suitable technology partners decide whether the NCEMT would be a good fit for upcoming projects.

The new Web site also houses NCEMT Engineering Knowledge Bases. These valuable resources, now easier to access, allow people to tap the wealth of information generated on Navy-funded projects. Engineering Knowledge Bases available at the NCEMT Web site include Powder Metallurgy Materials, Porous Materials, Thermophysical Properties and the Atlas of Formability.

Engineers And Scientists Publish Articles, Present Posters

The September 2002 issue of *Advanced Materials & Processes* contains three articles written by the NCEMT. Topics are "Titanium Armor Plate," "A New Product Form for Aluminum alloy 2519" and "Friction Stir Welding for the Advanced Amphibious Assault Vehicle." Future issues of the magazine are expected to cover additional articles by NCEMT experts.

The NCEMT was invited to present accomplishments in the poster session at the 2002 Defense Manufacturing Conference. These posters showcase information on titanium armor plate, advanced thermal battery production and aluminum alloy 2519 manufacturing development for the Advanced Amphibious Assault Vehicle (AAAV).



Navy Community Anticipates Shipbuilding Symposium 2003

ShipTech 2003: A Shipbuilding Technologies Information Exchange takes place January 16–17 at the Beau Rivage Resort & Casino, Biloxi, Mississippi. The event, facilitated by the NCEMT, is sponsored by the MANTECH Program and the National Shipbuilding Research Program—Advanced Shipbuilding Enterprise.

The agenda is scheduled to begin with welcoming statements by Steven M. Linder, Director, Navy Manufacturing Technology Program, Office of Naval Research. High-ranking representatives from Naval Sea Systems Command, the Office of Naval Research and Northrop Grumman Ship Systems Avondale Operations are expected to offer keynote addresses.

Information on future trends in shipbuilding technology will focus on transformation implications for the 21st Century Navy, trends in the Far East and the DD(X) Program.

Concurrent technical sessions will cover materials and production processes, business processes, and shipboard propulsion and auxiliary systems. Complete information and registration details are available at www.ncemt.ctc.com.

Technology Transfer Is One Formula For Success

Many who work at the NCEMT have found that it is an honor to achieve the respect of colleagues and to have their work acknowledged in national and international circles. As the U.S. Naval community continues to reinvent itself through intense transformation efforts, it will continue to rely on ideas and accomplishments from experts at the NCEMT and other key military-support organizations. Through arduous technology transfer efforts, the NCEMT and its partners remain ready for the challenge. ■

NCEMT Represented In Casting Textbook

Half of the 26 contributors to a newly published textbook, *Modeling for Casting and Solidification Processing,* are current or former NCEMT employees. This Marcel Dekker book, edited by Kuang-O (Oscar) Yu, covers many important aspects of numerical modeling of casting, semi-solid metalworking, melting, solidification, stress analysis, defect information and related topics.

World-renowned casting expert Merton C. Flemings of Massachusetts Institute of Technology writes:

"The combination of theory and application presented in the book represents the 'new engineering' of casting processes. It is recommended reading for the experienced as well as for the newcomer to the metal casting field."

Many foundational developments made through NCEMT funding are described. With great pride, the NCEMT contributing authors offer this resource as yet another method of transferring technology to the U.S. industrial base in support of MANTECH goals.

National Center for Excellence
in Metalworking Technology

Operated by

Concurrent Technologies Corporation

For the U.S. Navy Manufacturing Technology (MANTECH) Program

For more information, contact:

NCEMT Information Services
Concurrent Technologies Corporation
100 *CTC* Drive
Johnstown, PA 15904
Phone: (814) 269-2809
Fax: (814) 269-6480
e-mail: slippyc@ctc.com

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